Intelligent Transportation Systems (ITS) Concept of Operations (COO) Guidance for Virginia Department of Transportation (VDOT) District Level ITS Managers

Drafted by Stephanie Herbert,
Virginia Tech Transportation Institute
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Background
ITS is the application of technology to transportation systems in order to improve operations and maintenance. ITS includes such things as Variable Message Signs to enhance Traveler Information, and Weather Monitoring Systems to improve decision making and highway management. A Concept of Operations for ITS is a framework that addresses why, when, where, and what ITS will be implemented.

This guidance is an attempt to assist VDOT Districts, in particular along the I-81 Corridor, in planning and implementing ITS. Over the next 15-20 years the I-81 Corridor, in Virginia, will be widened from 2 to 4 lanes in each direction. This widening may cause significant safety and operational problems if it is not managed effectively. ITS can help Districts along the Corridor manage traffic flow during the construction and on-going system operations after construction is completed.

The target audience for this Guidance is the ITS Managers, or equivalent position in each VDOT District, who must manage the drafting of an ITS COO. One ITS COO has already been completed for the Staunton District. While this Guidance references the Staunton case throughout, it is not meant to suggest that each district should duplicate Staunton's document. Rather this guidance is meant to provide ITS Managers with a general process they can follow in developing their own ITS COO.

Purpose
Drafting a Concept of Operations for ITS is a good way to outline the role ITS will play in District operations and maintenance. The COO can address what ITS will do, when and where it will be done, and who will be responsible for making it happen. This guidance should help ITS Managers draft an ITS COO, or direct a consultant who is doing so for their District.

Format
A COO is not an operations plan and should not be written at that level of detail. Rather a COO for ITS should be written as:
- a mid-level operational concept that guides the development of ITS (the detail of the concept should be below a Vision statement, but above an Operations Plan).
- an overview of the processes necessary for the implementation of an ITS using the currently available and projected resources and technology.

The COO should be flexible enough to withstand changes in needs and technologies, without sacrificing a District's goals.

Approach
There is no 'cookie cutter' approach to developing an ITS COO, but there are some general steps that can be followed. This guidance lays out the steps in an ITS Concept of Operations Development Process and describes each step in detail. The guidance is broken down into three sections, described below.

The first section of the guidance is a flow chart called the '*Process for Developing an ITS COO.*' The flow chart moves step by step through the development of a COO using boxes and circles to represent action steps and outcomes. The flow chart reads as follows:
- White blocks with **bold** lettering represent overall action steps in the ITS COO development process such as Strategic Planning, Work Planning, and Functional Scenario Development.
- Grey circles with *italic* lettering represent outputs from each action step. For example, *Goals* are an output from **Strategic Planning**.
- Dotted lines are feedback loops to show that this process is not linear, but often iterative. For example, at the end of the whole process you may need to cycle back to the beginning and make sure your end product meets the goals you have for ITS in your District.

Section two is a set of crib notes that detail each step in the flow chart. The crib notes explain what each step is and how it can be achieved. The flow chart and the crib notes can be used together as a guide through the ITS COO development process.
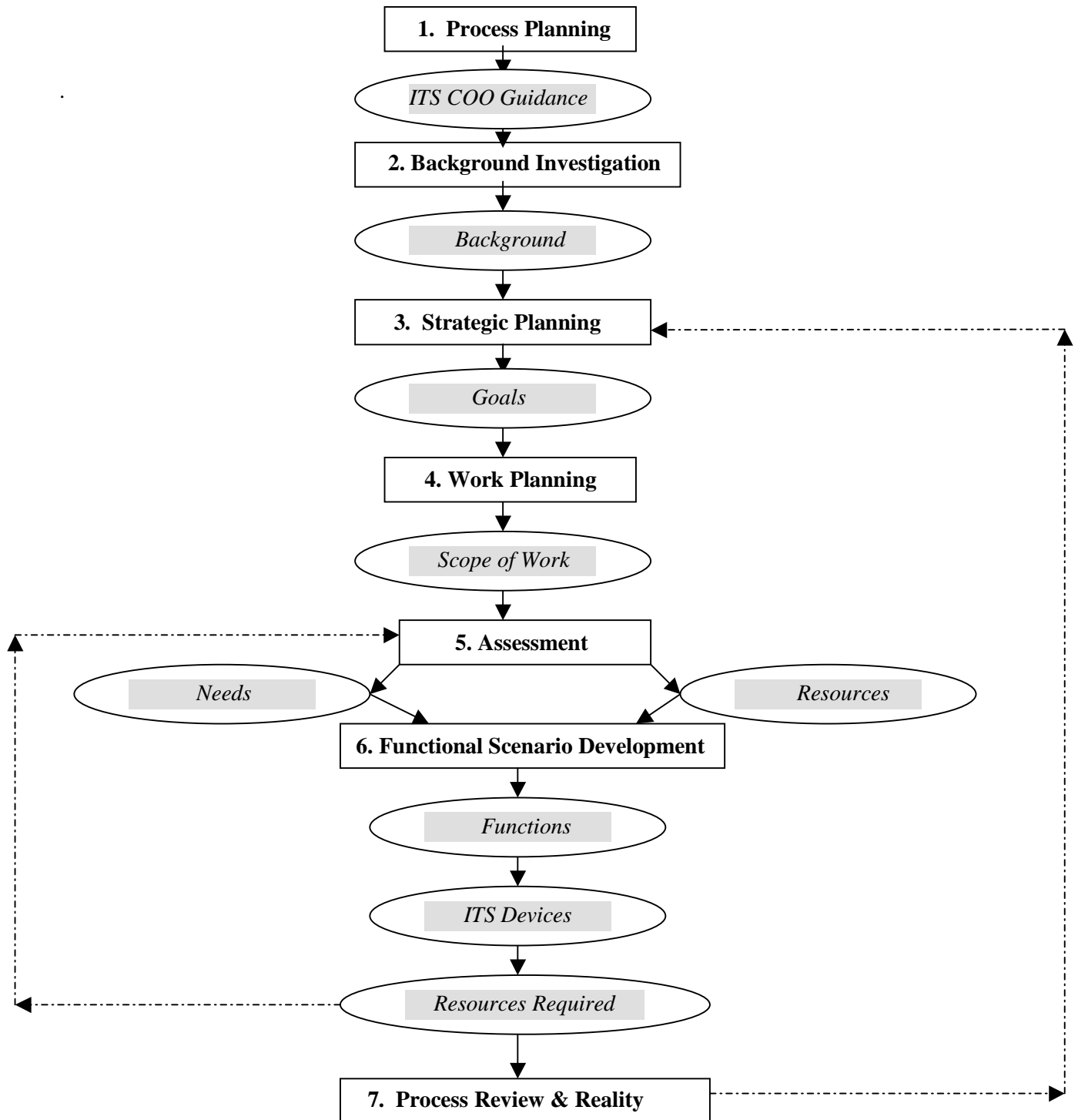
The final section of this guidance includes two appendices that provide examples of how this process plays out. These appendices include:

- **Appendix A**: <u>Interview with Robert Slocum, the ITS Manager for the Staunton District.</u>
  Mr. Slocum was in charge of managing the development of Staunton's ITS Concept of Operations and his insights into the development of Staunton's COO should help your District. The questions in the interview were broken down into the same categories used in the flow chart and crib notes.
- **Appendix B**: <u>Executive Summary of the ITS Concept of Operations for the Staunton District</u>.
  This summary should help you see the type of end product that your District may strive for. While Staunton's case offers a good example, you need to create your own unique ITS COO that addresses the specific needs and opportunities in your District.

Appendix A, in particular, is important because it provides first hand knowledge of the process and lessons learned thoughout.

This is a general guidance of the major steps to developing a Concept of Operations for ITS. This document is not a comprehensive listing of everything that must be done because each District is a unique case. If time and effort are dedicated to this process, a great deal can be learned about ITS and what it can do to support a District's goals and functions. Robert Slocum, the ITS Manager in the Staunton District found that, "at least half the value of this Concept of Operations is doing it."

Section I: Process for Developing an ITS COO

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Section II: Crib Notes for Developing an ITS COO

1. Process Planning
The first step is to outline a plan that will result in an ITS COO for your District. We recommend that you use this guidance. If you do not use this guidance, you should come up with some other method or plan of action. Having a plan will help to ensure that you do not leave anyone or anything critical out of the process.

2. Background Investigation
After you have a plan, do some investigating. Start collecting, reviewing, and documenting the Mandates, Plans, and District Administration Priorities that will guide the development of ITS in your District. For instance, you should investigate, among other things: the VDOT Strategic Plan for the 21st Century (1998), VDOT Smart Travel Strategic Plan (2001 Update), the VDOT Statewide ITS Architecture (1999), the Virginia Statewide Transportation Development Plan (2000-2001), and the goals and priorities of your District Administrator. You should be able to use these plans and priorities as input for the next step in the process, Strategic Planning. The information you gather will also be useful later in the process when you are trying to assess your District's needs and resources.

3. Strategic Planning
Once you understand the plans and priorities framing the development of ITS, you need to find out what goals are expected to be achieved by ITS in your District. If you find during your background investigation that a vision is already in place for ITS, you may be able to use it or expand upon it. Yet if it is not in place, it needs to be before you move forward in drafting a work plan.

To develop the District's goals, you should gather together, for a strategic planning session, the key stakeholders who need to determine the vision for ITS in the District. This might include, among others, you the ITS Manager, the District Administrator, the District Traffic Engineer, the District Maintenance Engineer, and the District Construction Engineer. It is advisable to have a facilitator guide you through a discussion of what the District's goals are for ITS. A clear statement of your District's goals and priorities should result from this planning meeting and it will serve as your guide throughout the remainder of the ITS COO development process.

For example, one goal in the Staunton District is to use ITS to 'Enhance Service to the Public.' This is just one of several goals that the Staunton District has for ITS. Each district needs to decide its goals, taking into consideration the other agencies, districts, and states they must work with who effect and are effected by the operation of ITS.

4. Work Planning:
Once you have established your District's goals for ITS, you need to draft a Concept of Operations. You may do this in-house or through a contract with a private consultant or university. Whatever method you choose, the District should designate someone on staff to manage the development of the COO. As the manager of the ITS COO development you must clearly define, with the organization that drafts the document, your District's expectations for your ITS Concept of Operations. In particular establish:
- What plans, requirements, and/or mandates constrain and guide the development of your ITS,
- What your District's goals and priorities are for ITS,
- What tasks you expect to be carried out in developing the COO,
- Who is responsible for each task,
- How and when reporting on tasks will be done, and
- What must be included and covered in the final ITS COO,

These issues should be discussed and clearly documented in a scope of work that defines tasks, timelines, and deliverables. If you do not do this, you may find yourself having to return to this step at a later phase, something that may be a frustrating and costly experience. Throughout, ITS Manager should be actively involved in providing input and overseeing the work of the organization developing the COO. Step five and seven should be carried out in tandem with the organization.

5. Resources & Needs Assessment:

After your scope of work is drafted, you need to assess the environment within which ITS will be operating in your District. This environment includes the resources you have on hand or may be receiving in the future such as staff, equipment, and funds as well as the needs you have for these resources. You can find this information out through research and interviews, as described below.

Research

Begin your assessment by learning about the resources and needs in your District. Do not get weighted down in details, remember that the COO is a mid-level document, not an operations plan. Detailed information will be needed later so keep good records of your findings for later reference. Below is an outline of some of the things you may want to cover in your research. The list is by no means comprehensive, but should give you an idea of the types of information you need to be gathering:

> **Critical Documents**: Research the plans and other documentation that can affect the development and functioning of ITS in your District now and in the future:
> 1. Reconstruction Plans,
> 2. Current & Planned ITS Technology
> 3. Current & Planned Telecommunications
> 4. Inventory of Existing and Planned Field Devices,
> 5. Regional and State ITS Concept of Operations
>
> **Internal & External Resources**: Consider the resources available for ITS now and in the future:
> 1. Current & Planned Staff, Equipment, & Office Space
> 2. Current & Potential Funding (Sources & Requirements)
> 3. Other Public and Private Sector Organization Projects and Resources (i.e. Universities, Telecommunications Companies, etc.)
>
> **Critical Data**: Review the data that is already available to support ITS and the gaps in data that the ITS could help to address, such things as:
> 1. Traffic Counts
> 2. Crash Data
> 3. Weather & Road Conditions
>
> Consider the quality of your data and its sources (not just VDOT sources).

Research will give you a foundation of ITS knowledge and understanding to build upon so that you can make informed decisions. Research will also provide you with background about the agencies you are interviewing. This background knowledge will help you create an interview instrument that enables you to gather the information you need.

Interviews

After you have done some research, you may want to meet with key stakeholders in the field, such as resident engineers and state police captains. Prior to the interviews you should learn as much as you can about the interviewee's organization and domain. For example, if you are meeting with a resident engineer, be familiar with the their residency boundaries and roadways.

Prior to the interview, send your interviewee information that will prepare them for the discussion. Ask them to gather together documentation such as the location of ITS devices in their residency. This pre-interview preparation will orient you both with the material being discussed.

During the interviews, ask questions that will enhance your knowledge of District needs and resources as well as what functions/operations ITS might enable. Ask stakeholders, among other things to:
- Describe their day, evening, holiday, incident, and weather condition operations,
- Identify and discuss the problems they are facing in various operations,
- List the agencies they work with and describe the information they share, and how they communicate,
- Describe any ITS that they currently use or would like to use,
- Verify the information you have from your research and find out if you are missing any critical information or stakeholders,

This list is by no means exhaustive, yet it provides you with an idea of the types of questions you need to address in your interviews. It is critical that you come to understand the operations of the agencies that will be using ITS in your District so that you can determine the functions ITS can enable.

Speaking with stakeholders is also an opportunity for ITS Outreach and Education. Share with them information about ITS and inquire about what they already know and do with ITS. This is an opportunity to help the people who will be involved in ITS implementation to be better prepared to work with and maintain equipment once it is in place.

It is important to raise awareness in the field, shop, office, and in management about ITS and how it will support and enable current and future functions. The research and interviews you conduct should be educational and informative for both you and the participants. In the end, all of your research and interviews should provide you with what you need for the next step, Functional Scenario Development.

6. Functional Scenario Development

At this stage you need to define your functional scenarios, or potential paths for achieving your goals considering your resources and needs. There are three parts to a functional scenario: Functions, ITS Devices, and Resources Required. Each part is described below:

> **Functions**: After Goals are clearly defined, and an assessment is complete, you can begin to consider the Functions ITS can enable. The Functions should be broad, general ways to achieve your goals using ITS. List here the most desirable and feasible functions that ITS could perform considering what you learned in your assessment. For example, the goal of 'Enhancing Service to the Public' could be achieved via the function 'Information Dissemination'.

> **ITS Devices**: After the Functions are listed, you should consider what ITS devices are available to enable your functions. These devices should work together in an integrated fashion with your current and projected technologies and with other ITS devices you are considering. Ask yourself at this step:
> 1. Does this device enable one or more of my priority functions?
> 2. What other agencies need to be involved in implementing this successfully?
> 3. Will their current and planned systems integrate with ours?
> 4. Will this device integrate with other technologies we have and are considering?

To carry out our current example, you might use the ITS device 'Variable Message Signs' to enable the function of 'Disseminating Information' and thus achieve the goal of 'Enhancing Service to the Public.' ITS devices can not be chosen in isolation but should be integrated with other technologies you are considering and those that are already out in the field.

Resources Required: Once you have chosen several ITS devices that can work together in a strategic and integrated fashion, you will need to consider if you have the staff and other resources you need to operate and maintain the devices. The devices you choose may need to be reconsidered or staged differently when you look closely the staff, monies, and equipment you have and are projected to receive. Ask yourself questions such as:
1. Is the cost of this device feasible not only to purchase but to install and maintain?
2. Will the device require new staff or training of current staff to operate and maintain?
3. How much will new staff and training cost?
4. How much space will the operation and maintenance of this device require?

After you have asked these questions, you should draft a budget and list of resources needed to make each scenario possible. Stage the scenarios into short-range and long-range considering current and projected resources and technology. The functional scenario development should not turn into an operations plan, rather the questions you address should lead to a recommended list of desirable and feasible functional scenarios and some details on what resources will be required to make them work.

For example, in the Staunton District, Variable Message Signs are being proposed as a way to achieve one of their priority functions, 'Disseminating Information'. VMS is being proposed because there are already signs available and because it is perceived as an effective way to provide the public with information. Staunton also made this choice of VMS because they have money from a federal grant to build a District Operations Center that will support the increased staff and equipment necessary to operate the Variable Message Signs and other ITS devices Staunton wants to implement. Their choice is related to the needs and resources they have and the resources necessary to make it work.

In reviewing Staunton's ITS COO it is clear that the ITS Manager carefully surveyed the District's resources and needs and came up with current and future scenarios of how ITS will work in their district. The Staunton ITS COO also documents the resources needed to carry out their scenario's successfully. For more information on Staunton's plans you can refer to the Executive Summary for their ITS COO, found in Appendix B of this guidance.

Functional scenario development is not a simple task, but it is logical. Move step-by-step through the process and remember that you may need to cycle back up to earlier steps in the process to refine your information. The functional scenarios are the most pliable part of the COO because they can be adjusted without affecting the goals for your District. If an operations planning process determines that a functional scenario is not feasible, as earlier believed, the scenario may be altered with the spirit, integrity, and direction found in the Goals remaining intact.

7. Review and Reality Check
After you have defined several functional scenarios it is time to reflect back on the Strategic Plan and determine if your goals can be fulfilled with this COO as a guide. Make sure you have covered all your bases and not left any key documents or players out of the process. Before you finalize your Concept of Operations, you should also meet with key stakeholders in you District, likely the same group you met with for the strategic planning session at the beginning, and ask for their input and comments.

Concluding Thoughts
Use the COO to inform and enlighten the development and operation of ITS in your District. Remember that there is no 'cookie cutter' approach to developing ITS, in particular for a rural area where such systems are quite new and unique. Define your vision, understand your environment, and create a COO that will guide the development of ITS to serve your District.

Appendix A: Interview with Robert Slocum, Staunton District ITS Manager

Interview with Robert Slocum, Staunton District ITS Manager

After the Staunton District Concept of Operations (COO) was completed, a two hour interview and open discussion was held with Robert Slocum, the Staunton District ITS Manager in order to find out how the ITS COO was developed and what lessons he learned throughout the process. This interview proved to be very informative and should help other ITS Managers at the District level as they seek to develop ITS COO documents in their own districts.

Interviewer: Stephanie Herbert, Virginia Tech Transportation Institute Interviewee: Robert Slocum, Virginia Department of Transportation, Staunton District.

I. Developing an ITS Concept of Operations—Getting Started

What was the catalyst for the creation of this ITS Concept of Operations?
We had been inching along, getting some devices called ITS and getting some ITS capabilities and even starting to get some ITS Funding. Then big funding came from a federal grant. We really didn't have a plan for how to institute it and thought an overview, or document to get ideas in and generate discussion would be a good way to start. We wanted to give people an opportunity to provide their thoughts and input. The federal grant also required that we have a concept of operations when spending the money.

What resources and support did you have to carry this ITS COO development forward successfully?
We have me, who still has 1/2 time or even 3/4 time devoted to this ITS effort. I believe without someone nearly full-time, it would be a very difficult effort. Also, I think it is important to have a single person who knows what is going on with ITS in the District. I am hoping that our work here will simplify the process for the other Districts, even if they want to change it at least the ideas are still there.

II. Developing an ITS Concept of Operations—Process Planning

Did you have a process you followed, outlining how you wanted this concept to develop?
The process was to ask the consultant to develop a scope. Then we went back and forth a couple of times on that scope. So that was the first step, to develop a scope for this concept of operations project. The process within the scope was to simply identify needs and attempt to answer the question whether ITS could satisfy any of those needs or provide solutions to what is going on in the District.

In the beginning, what did you expect from the final Concept of Operations document?
In the beginning, I expected the final document to answer any question that would come up from the District Traffic Engineer, the District Administrator, the Assistant Commissioner for Operations or the Central Office Director of ITS. I wanted it to answer what will happen if A happens, or what will happen if B happens. Basically a document that lists out a protocol of who does exactly what on a daily basis. I was wrong. Somewhere the actual outcome should be explained. Needs, justification, budgets, personnel and device requirements should be detailed along with how a FHWA required architecture will be provided.

Did you have any basis for your expectations? What shaped them?
No I didn't. What shaped my expectations was, simply, the title 'Concept of Operations' and the need.

How did you plan to fit this ITS Concept into the traditional VDOT planning process?
ITS and the traditional planning process are a little bit different. The fact that we have federal grant money in a way expedites that planning process, it is dumped in your lap. That is a lot different that the traditional planning process where you identify the need, and you've thought about it for five years because it has been in the budget so you are ready to go as soon as you get the money. In this case the money came first and then the planning second. As long as you are getting money like that I think it is going to be fairly difficult to have a single planning process that is going to accommodate for instant money versus long-term planning money.

III. Developing an ITS Concept of Operations—Background Investigation

What documents and district priorities did you need to integrate into the development of your COO?
In the beginning of our executive summary we list each document. They include, among others, the Statewide ITS Framework and the Staunton District's ITS Mission. Current and potential needs were also discussed with the Resident Engineers in each residency, District Administration, District Traffic Engineering, ITS Division, and the I-81 ITS Technical Planning and Implementation Team.

Did you discuss with your District Administrator and/or others what should be included in the COO?
Yes that was separate from this document. That occurred before. We had two formal discussions with the District including the District Administrator, District Operations, and the Resident Engineer where we tried to sort through the idea that we had some resources to do something immediately, now what did we want to do? It takes everyone's involvement, and there are documents in place and people in place that must be considered and must be part of the process.

IV. Developing an ITS Concept of Operations—Strategic Planning

What were the Goals set out in this Concept of Operations?
The goals of the COO were to identify areas in the District or in VDOT where ITS or technology could solve problems or make people's jobs easier or more efficient. A traveler may or may not see it on the road, it may be a sign or a device that provides data to a VDOT staff person that allows that person to adjust something. Whatever it is, it makes a difference and improves customer service or efficiency of VDOT. Really that was the larger goal. Specifically the COO would tell us how to get infrastructure and people in place to get it done.

When did you set out these Goals?
The way we approached it, I think, was to talk to folks in the residencies, central office, and district. We asked them what they do, how technology might be able to improve their job or help their staff. I think we never really spelled those out but I think it would be good to do so.

Also several of us here in the District Traffic Engineering Group had a meeting about goals before this Concept of Operations even got started. The outcome of that meeting is in the grant application that says we want to improve safety and do things that the end user can see. And then we applied devices to that.

Did you have a Strategic Planning session before you started this COO?
Yes we did have a strategic planning session run by the Virginia Tech Transportation Institute. But before the planning session, as I mentioned, I had a discussion with the other Traffic Engineers in the District. We identified what we wanted to accomplish in real terms, we were broad enough in our

discussion and did not back track in the planning session that followed. We honed in on the ideas that we had developed earlier.

Do you think anyone was missing from that Strategic Planning session that was run by VTTI?
No.

The meeting included the VDOT Assistant Commissioner for Operations, VDOT Acting Assistant Commissioner for Research & Technology, VDOT ITS Division Director, Staunton District Administrator, District Construction Engineer, District Maintenance Engineer, District Traffic Engineer, Resident Engineers, and yourself?
Yes, they were involved.

Were the Goals that were established at that planning session carried through into the COO or was there a break between the planning session and the development of the Scope for the Concept?
Yes it all fits together and it goes back to when we received grant money and had to do something. At first, our Traffic Engineering Group met and we developed how we were going to spend the money, and then VTTI came in and helped us work through it. But all of that was done to write the application for this grant money and then the concept came in. So yes, we went through a whole process of first detailed discussion and then strategic plan and then Concept of Operations for ITS. We didn't do the strategic planning within the concept, we did it prior to the concept, with the idea that we were going to do this document.

V. Developing an ITS Concept of Operations—Work Planning

How did you decide whether to do this in-house or to have a consultant draft the Concept?
The Director of ITS in the Central Office said that we needed to do a Concept of Operations and that PB Farradyne could do it. Originally I thought because we did the application for the grant on our own that we should do the concept on our own. However, the concept is much larger and gets into an area that requires more technical expertise. I thought that someone who has been in other places and seen other things in ITS would be better because they can see things I can't see and have that overview approach. That is why we decided to stick with the consultant approach. We thought that they offered an expertise and overview approach that we did not have.

How and when did you lay out your expectations for the Concept of Operations to the consultant?
The consultant was contacted by the Central Office in VDOT, we didn't initially meet. While I was waiting to hear what the consultant proposed in the scope, I formulated some ideas about what we should get out of this, what the goals should be. I took a common sense approach, I wanted to look at how we are operating now and how we want to operate in the future. I thought this document called 'Concept of Operations' should certainly answer those questions for us.

How did you divide up tasks between you and the consultant in order to get everything done?
We made an itemized list of the functions to be performed and it was the tool we used to define the job.

How did you monitor the progress made on the Concept development?
I monitored it through my participation in the discussions with the groups that the consultant met with internal and external to VDOT on the tasks. Unfortunately tasks were not submitted the way that we originally intended, but it was agreed that it was acceptable. The proper way to do it would have been to report to us what progress they had made, what they had seen, and what they had observed on a monthly basis or whatever works. I also participated in the interviews, that was key. I reviewed the questions that they had for the interviews, but since they were the experts, I was a bit hesitant to change what they had done. I just kept an eye on them.

Is there is something in this part of the process, the scope development, that you would have done the same and/or differently?
First, I would have, from the beginning, developed a scope of my own before I even saw the consultant scope. I would address what a concept of operations means to me, and what I expect out of it. Then I would look at what they submitted and compare the two, discuss it face to face with them, find a resolution with clear time frames noted on when we are going to reconvene to make sure this thing is still on track. Make sure we understand what each of us thinks we are getting. And if I were uncomfortable with some of the things that were suggested or didn't feel they made sense I would be more assertive in saying so.

VI. Developing an ITS Concept of Operations—Resource & Needs Assessment

What sort of information did you collect during the development of the COO?
We gathered information to see better how VDOT works from top to bottom, by no means all inclusive, but a better idea. From the area headquarters we looked at what their responsibilities are, how they performed through incident management, daily activities, and weather. Same goes for the residency and the district. We learned what programs are being worked on in central office, VOIS, Crash Data, and the ITS Divisions statewide efforts. We learned the opinions and gained direction from the resident engineers, district traffic engineer and district administrator.

But I don't know if you could go through and just do the concept of operations without attending other functions and still come away with the same information. I think you would miss quite a bit. If you focused just on the concept of operations and on the district you'd miss something. For instance, I went to the conference at the Virginia Transportation Research Center and heard JR Robinson (VDOT ITS Division Director) and Andy Bailey (VDOT Assistant Commissioner for Operations) speak about ITS. Going out of the District you hear and learn different things that you wouldn't otherwise. That is why I think there needs to be someone dedicated to ITS, who knows the big picture statewide.

When and how did you begin your information gathering?
The first task of the scope was to go out and perform interviews. It is important for both parties that you send some information to the residencies or whoever you are going to be talking to before the interviews. And you could be familiar to an extent with their residency and the lay of the land so you are both not coming in cold. Be realistic about it. One of the whole reasons behind going out to the residencies is to discuss with them their problem areas, it is likely not documented anywhere. You could pour through crash data, but to get a real sense is to talk to the resident engineer. Also, it is important to just be involved in ITS on a daily basis.

What were the most effective means you found for collecting this information?
The face to face discussions.

What information did you find the most useful when developing the Concept of Operations?
The understanding of operations, what people are looking for, what they feel would assist them, and what types of problems they deal with.

Who were the most critical people you talked to?
Resident Engineers. But that needs to be balanced with the District Administrator and District Traffic Engineer. In another district that may be different, it may be the District Operations and Maintenance Engineer who really oversees and does what the District Administrator did in our case. Our District Administrator provided feedback and a vision, he really liked to be involved. I think each district needs to see what the task at hand is and then identify people in their district.

Would you do anything differently during the information gathering, and if so what would that be?
I would've had a more organized approach to what we did, providing information to the folks we were talking to up front. We did provide them with questions, but we didn't provide some capabilities up front to get people more accustomed to what we were talking about. Also I would have had the same person/interviewer in each interview and no more than two consultants at an interview.

VII. Developing an ITS Concept of Operations—Functional Scenarios

After completing your information gathering, what did you see as the primary functions for ITS in your District?
I boiled it down to data/information collection and information notification. Those are the two big functions. First to get information that is helpful that is going to allow us to do something we couldn't before or do it better. Then notification either using that data or using people that we already have in place and their voice just to get the word out through equipment to drivers. It is also information to VDOT staff and VSP. Closing the communication gap between the service providers.

For instance, data collection, how fast is a car going by this mile marker today versus yesterday versus tomorrow versus the holiday versus various weather conditions. That is collection. You may not put that on a variable message sign, but it is still data collection for ITS because I can turn around in an automated fashion or a manual fashion and tell the District Traffic Engineer or the Virginia State Police the average rates of speed. They have said that would be useful information.

So, the two functions were, as I see it, collection and notification. There is also a third function, a control aspect, like for our signals. Remote control of the signals or remote analysis might save a two hour trip to Clifton Forge, that is what ITS can do.

Did these functions tie back to the goals set out by your District Administrator and others?
Yes.

How did you choose ITS devices to enable the functions that you chose for the district? For example if Information Gathering was one of the functions set out in the COO, how did you choose the ITS device you would use to enable that function (i.e. Road Weather Information Systems versus counters)?
Like anything else, we did it based upon learning, availability, and long-term considerations like maintenance. The type of area we had to cover has helped us to choose because some of the capabilities we would otherwise like to choose, like detection, can't be done in our area without a significant budget.

When trying to choose ITS devices, did you gather enough information in your interviews, or did you find that you needed to go back to gather more information?
We got enough information through the interviews to complete the Concept of Operations. But when it is bound and printed it is not the document that we will turn to like the law and say 'you are getting seven RWIS stations and they will be here and here.' My plan is to take the Concept as an idea that looks at the entire district, and then go to each residency and say 'you've seen our plan and here is what we'd like to do in your residency, does this seem appropriate to you?' What they want will shift.

Also, we could get to the stage of staking out an HAR or a camera and find out we don't have the power in that particular location, or the environmental conditions are not conducive to what we want to do. That gets further down the road then this Concept. What this Concept does is identify functions and what we are trying to achieve, it gives us some direction, and lays out what we have to work with, a budget and

that type of thing. This is really just a preliminary engineering document and it would take PI funds to do this.

How did you outline the resources necessary to carry out the functions you are proposing?
It is a combination of resources necessary, resources available now, and resources we think we can get our hands on in the future. We shoot a little high above the resources that we have to support what we want to put out, but we ask for more resources. It is just like any other thing, we might have a bridge engineer who says I want to rehab ten bridges this year, knowing that it actually maybe only seven that he can do or that he will be approved to do. But he certainly wouldn't ask for 20. It is part of the Concept of Operations to outline the resources. You need to look at what you have and where you need to go.

How far in the future did you project your scenarios?
We did a Phase I and Phase II. Phase I is for the next two years. One of the big reasons is that in the next two years we hope to be a lot different operation in that we will have another person on staff, if not two, we hope to have a building in place to operate out of, and a few more devices. But essentially we hope to have a groundwork layed in Phase I. Then we can assess where we are and move forward to the next phase. But until we get that groundwork layed, it would be premature for us to go out four years and say after we get this built we are definitely going to do this. But we do have ideas for things to do.

Why is the District Operations Center (DOC) such a large part of this COO and what role does it play in the District?
A lot of things are going to go in and through and out of that DOC, but the focus of the Concept of Operations needs to be on what can ITS accomplish, not on the building. I think the whole focus needs to be on something for the long-term good of ITS, what is going to make people say 'I really want to have ITS' people driving their cars, people in VDOT, and people in the news.

Remember that the DOC is just a building, it doesn't achieve our function of collection. I see ITS in our district as having the function of collecting data and distributing data. But that isn't the DOC, that is ITS, the whole picture. The DOC doesn't do the collection and distribution, other equipment is doing that. The DOC is a conduit for it. The DOC is not an ITS like the Afton Mountain Camera system or Travel Shenandoah, the DOC is a resource to support an ITS. From a very essential point of view, I've got an ITS so to speak if I have two signs. Information can come in from the field and I can put it up on a sign. I don't have a DOC, but that exchange of information, is ITS. It got collected and put out.

We need a DOC because we do not have 10 square feet of space. But you could go to another District and maybe they have a cube space that is not being taken up. Maybe in their concept they see three phases at two, four and six years and they don't find they need a DOC until the third phase. That is part of their COO. Just like we specify we need 5 people, we specify we need a DOC above and beyond our current building as part of the COO. It shouldn't come in until it is warranted. Our DOC made perfect sense, because of our space limitations, location, district real estate, our plans, our money that was coming in. Maybe another District is in a different position and they don't need a DOC to operate their VMS. But with ours we might as well go ahead and do it and consider all these functions in the DOC now.

VIII. Developing an ITS Concept of Operations—Process Review & Reality Check

What happens now to this Concept of Operations document? How will it be used?
I don't want to downplay the value of the COO once it is done. But to me, at least half of the value of this COO is doing it. Is going through the process. If you have a person who has walked through the entire process it gives them a much better feel for the world that they are operating in as far as ITS goes. That is the first thing.

The second thing is that now that it is done and in a document, I expect that it will be current for a year and a half, hopefully two years, to the end of Phase I. But beyond that I don't know that it will remain current without someone continually updating it. I will use it to plan for the next two years and use it to measure what we are trying to accomplish. We can look at what equipment and solutions we are trying to provide versus what we have in out budget, what we need to get out of our budget, or what more we need to ask for.

So this Concept is going to be a balance, so to speak, in a check and balance system. It will keep us aligned with all of the effort and discussion and forums that it took to get us here. Hopefully it can be used, if necessary, as a tool for reasoning that says 'we don't need to go back to step one because we have a document of how we came up to this, lets not go back and throw away the plans.' Maybe an idea here is to have this be an iterative process, perhaps without a consultant next time, where ever two years this thing be perused and updated if that is how people find it useful.

What are your next steps?
We have already started the next steps, we have been inching along. The next steps are to get these projects in place. First of all, let me say that if we didn't have line items in the budget for some of these things, our next step would be to get this into next year's budget. And that is what we will have to work for, for the longer-term projects. But for the shorter-term projects, the next step is to get project numbers out of these, get the preliminary engineering specific to that project accomplished. We need to meet with the residency representatives who care to be involved, perhaps in the field, or wherever it may be to discuss where these devices may help while keeping a district wide perspective. I guess the short answer is the next step is to implement projects that are suggested in the Concept.

What do you need to do to get the projects implemented?
We will need to write contracts for each one of these projects that require a contractor, the majority of what we are doing requires contracting. That would be where the rubber meets the road, is getting that contract.

How do you believe this District Concept should mesh with the Regional Concept of Operations? For instance, how can the Regional COO support your goals and vice-versa.
There needs to be a consistency on the corridor, hopefully statewide, as far as how to operate or give messages, or priority to messages. We don't want to confuse people, but make their travel across district boundaries invisible. I see this Corridor Concept of Operations Working Group as an oversight body, a check and balance system that says, 'Bristol we see you have 40 signs, side mounted, on primary routes leading to the interstate. Staunton you have 10 signs, overhead on the interstate. Why are we taking two different approaches? Is it reasonable?' And if so, fine. And if not, then should we consider something else? It is really simple stuff, if we could just agree and have some guidance. I see this regional thing as a guide, a check and balance. I also see the COO Working Group as a way to get money.

IX. Developing an ITS Concept of Operations—ITS Education

What level of ITS Education did you feel you needed to do during the COO? Was this enough?
I don't know if there is a video available? It would be good to have a video that goes out to those folks who are supposed to benefit from ITS and show them how they will benefit from it in real practical ways. Not the pie in the sky stuff, but the bottom line, how it will reduce their headaches.

X. Development of the ITS Concept of Operations—Lessons Learned

Did you run into any problems in the development of the Concept that you would tell other districts to avoid or handle a different way?
Have an idea of what you want to accomplish before you get started. Don't necessarily let the 'experts' tell you what you need, how, and when. And decide your budgets for yourself. Just take a common sense approach to this.

Did you come across resources or opportunities in the development of the concept that other districts may want to pursue?
If they are interested, I think the best thing is for them to look at what we have done. That would benefit them a lot. See if there is something that interests them.

What words of wisdom would you offer to other districts?
Keep those who are going to operate this system involved, those who will have a big part, the stakeholders. Make sure those people are involved from the beginning. If you feel like you are really going against the grain, seriously consider what you are doing because even if it is a good idea, if it is not implemented, then it won't be a success. You need the support of the stakeholders.

Appendix B: Staunton District ITS Concept of Operations Executive Summary

Executive Summary

The Staunton District of the Virginia Department of Transportation (VDOT) is committed to Intelligent Transportation Systems (ITS). The Staunton District Year 2000-2004 Strategic Plan includes an initiative to Implement Intelligent Transportation Systems. The Outcome Desired: Informed drivers, reduced congestion, and greater VDOT efficiency. The VDOT Year 2000-2004 Strategic Plan also identifies the increasingly important role of ITS:

- "We will be a leader in utilizing innovation and technology to deliver our products and services."

- "By 2002, VDOT will improve its use of new information management and engineering technologies"

- "Integrate Intelligent Transportation Systems into the transportation planning, engineering, and operational processes."

- "Lead the proactive development, promotion, and use of capacity enhancement measures such as those available within the Intelligent Transportation System and the Traffic Management programs."

In the District, several ITS applications have already evolved from the desire to maintain the highest level of service to travelers through the most efficient means possible. Progress has come in the form of sophisticated traffic signals, video detection, highway advisory radio, variable message signs, and Travel Shenandoah. Greater traffic volumes, Interstate construction, rapidly evolving technology, and public and political attention dictate that the District continue advancing ITS services. That effort begins with this document.

The "Staunton District ITS Concept of Operations" will set forth a formal plan to fully realize the benefits of ITS. To do that, it will address both a technical audience who will build the system(s), e.g. software engineer, as well as an administrative audience who may guide the effort through a short and long-term vision, e.g. District Administrator.

This document is not an incident management plan. "The Staunton District Incident Management Control Plan", "The Commonwealth of Virginia Emergency Operations Plan", and "A Guide to Emergency Operations and Planning For VDOT" all provide guidance for incident management purposes.

The Statewide ITS Framework developed by VDOT in coordination with the National ITS Architecture provided technical guidance. That framework and the District's ITS mission statement will allow for the systematic deployment and integration of ITS components throughout the District. The Staunton District's ITS mission is as follows:

"The Staunton District's mission as related to ITS is to enhance roadway safety and effective capacity in rural, urban, maintenance, construction, and incident settings through cost-effective technological solutions in coordination with stakeholders internal and external to VDOT."

This Executive Summary overviews the Staunton District ITS Concept of Operations. It Includes:

- A definition of an ITS concept of operations

- The methodology used in developing the Staunton District ITS Concept of Operations

- The current status of ITS in the Staunton District

- The Phase I short-range program, years 2001 and 2002

- The Phase II long-range program, years 2003 through 2010

- Staffing recommendations

- Messaging protocol recommendations

ES-1 The Staunton District ITS concept Of operations

This Concept of Operations was undertaken to ensure that the District's ITS Program has a clear direction and to support the procurement of devices and software that are of value to VDOT. A concept of operations identifies the "who, what, when, and how" of ITS operations. The first step was to define who does what related or potentially related to ITS. Next the process of defining when they do it, and how was considered. Finally, ITS capabilities and requirements specific to the District were addressed.

The concept of operations will assist the District in the procurement of ITS equipment and software by providing high-level descriptions of desired functionality. Before investing millions of dollars in highly specialized equipment, a concept of operations is necessary to specify a "game plan". The plan must consider current and future functions in current design. It is difficult and expensive to modify software and hardware to include new functions after it has been initially developed. Specific Data flows and communications now and in the future are an example of the details analyzed in the document.

The concept of operations for the Staunton District includes a short term Phase I program plan that establishes a foundation the District will build in the next two years. A long term Phase II program is then identified. The long-term plan is more a planning tool to begin considering future needs and solutions. As technology, capabilities, and needs change, the specifics of the Phase II program are certainly open to change.

ES-2 Methodology

This document is the initial effort in the Staunton District to address ITS activities as an iterative, evolving process. From a broad perspective, Figure ES-1 below demonstrates that process.
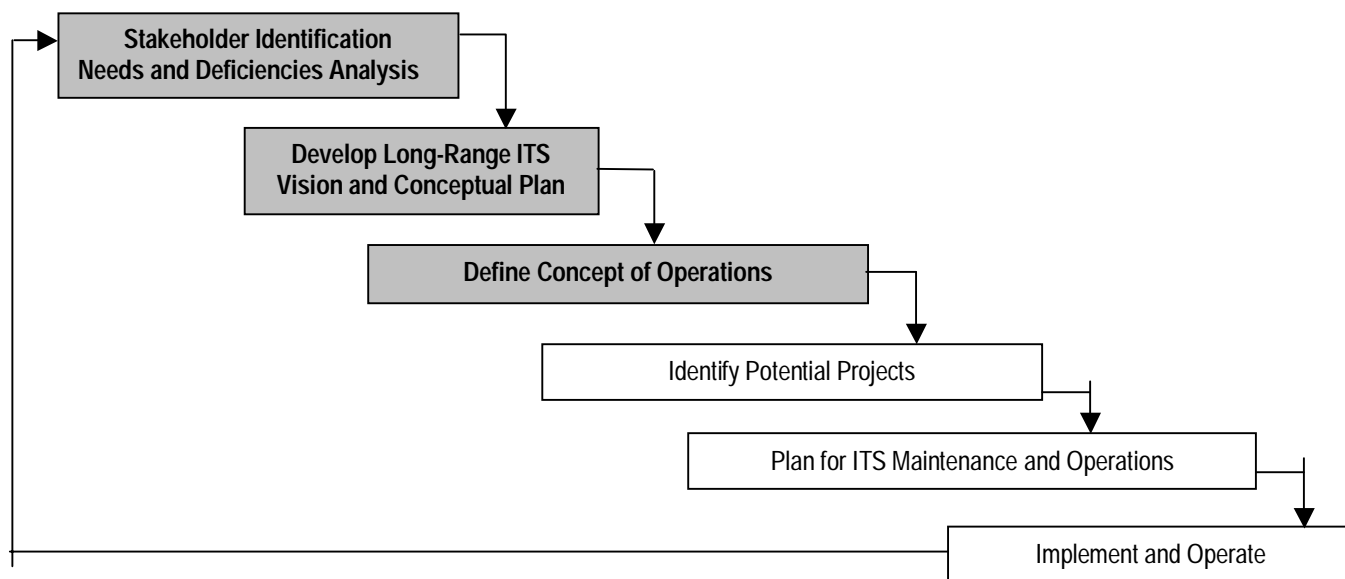
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│  Stakeholder Identification   │
│ Needs and Deficiencies Analysis│
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   │  Develop Long-Range ITS   │
   │ Vision and Conceptual Plan│
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      │ Define Concept of Operations│
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               │ Implement and Operate │
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Figure ES-1
ITS Solutions Process

Communication internal and external to VDOT was one of the greatest benefits in undertaking this concept of operations. The approach was to first learn the activities of current and potential ITS stakeholders. Information was gathered and evaluated at several equally important levels; Residency, District, Corridor, and State. In meetings with each level, transportation issues and ITS capabilities were discussed. The findings and recommendations in this document are based on information gathered from the following groups:

- The Resident Engineers of Edinburg, Harrisonburg, Lexington, Luray, and Verona.

- District Administration and District Traffic Engineering

- VDOT Central Office ITS Division and Data Management Division

- Transportation Emergency Operations Center (TEOC)

- The Interstate 81 corridor Technical Planning and Implementation Team.

- Adjacent VDOT Districts and Adjacent States

- Virginia State Police (VSP)

- Local agency 911/Emergency Operations Center (EOC) managers

Analysis and solutions included herein are based upon current operations, proven ITS approaches applied across the country, and available information on emerging technologies.

ES-3 ITS in the Staunton District Today

The following summarizes the ITS equipment and activities now in place in the Staunton District.

ES-3.1 District Field Devices

The following lists ITS equipment within the District:

- Seven (7) fixed Highway Advisory Radio (HAR) sites
- Two (2) overhead Variable Message Signs (VMS)
- Four (4) road/weather information sensors
- Twenty three (23) permanent count stations
- One hundred and fifteen (115) traffic signals including:
    - Fifty (50) traffic signals with dial up communication
    - Twenty-two (22) traffic signals with video detection on one approach or more
    - Seventeen (17) traffic signal systems capable of being coordinated
- Two (2) portable HAR
- Seventeen (17) portable changeable message signs (PCMS)

The Verona Residency and the Staunton District are currently installing an upgrade to the existing Afton Mountain Fog system. The system consists of:

- Two (2) visibility sensors located on Interstate 64
- Two (2) road/weather information sensors located on Interstate 64
- Two (2) Overhead variable Message Signs over Interstate 64
- Eight (8) side-mount variable message signs on approaches to Interstate 64
- Raised pavement marker lights along each edge line.

ES-3.3 District ITS activities

The Staunton District is currently pursuing the following ITS initiatives.

- A Federal Highway Administration ITS Integration Grant has been awarded

- A Staunton District Traffic Operations Center will integrate Traffic Engineering and ITS

- Two MEL positions have allocated to support and develop ITS

- Additional detection and notification devices on Interstates 81, 64, and 66

- Signalized intersection improvements including coordination and remote capabilities

- "Smart" Work Zones planned for future Interstate 81 construction

- An Interstate 81 corridor approach to messaging and software systems integration.

ES-3.4 Travel Shenandoah

Travel Shenandoah (TS) is a unique cooperative venture composed of Shenandoah Telecommunications Company (SHENTEL) and the Virginia Tech Transportation Institute (VTTI) under the sponsorship of VDOT and the Virginia Tourism Corporation (VTC). Additional partners include the Virginia State Police (VSP), the Shenandoah National Park, and the Shenandoah Valley Travel Association. TS is a real-time traffic, traveler services, and tourism information service for the Shenandoah Valley of Virginia. Begun in April, 2000, TS provides travelers, tourists, and local residents with up-to-date information on:

- Real-time travel alerts
- Current road and traffic conditions
- Food and lodging
- Traveler services
- Tourist attractions

- Current events
- Trip routing
- On-line shopping
- Automated reservations
- Commercial Vehicle Information

Travel Shenandoah shares boundaries with the Staunton District. If successful, TS plans to expand service to the entire I-81 corridor within Virginia, through West Virginia, Maryland and along the Interstate 81 corridor to Harrisburg Pennsylvania.

Currently, TS gathers and disseminates traveler information via the Internet and an automated, voice actuated telephone system. Information is available to pagers and faxes via a subscription service, and via cable television. In the future, it is anticipated that there will be automated links from Travel Shenandoah to information kiosks and counter-top terminals at welcome centers, rest areas, tourism sites, and other public locations. TS is one of the first in the nation to propose a 511 traveler information access number for their coverage area.

ES-3.4 Current ITS Operations In The Staunton District

Current operations focus on the operations of field devices, incident management, and signal operations. The following functions are in place:

- Public Information has the capability to post messages on HAR. District Traffic Engineering and soon TEOC or VTTI will have the capability to post messages on VMS. Residencies may wish to use whichever of these capabilities they see fit. Traffic Engineering typically posts scheduled messages for planned closures and maintenance. TEOC or VTTI will address the VMS and HAR during off hours. Nearly all requests for posting a message on VMS and/or HAR originate from Residencies or Area Headquarters, and in some cases from the District Office.

- Residencies monitor road and weather information systems to assist in the prediction and response to storms. Some residencies rely heavily upon publicly available weather services such as The Weather Channel on cable television and the internet.

- Residencies and Area Headquarters communicate with local emergency response agencies and the VSP by telephone. Residencies and Area Headquarters maintain call lists of key contacts for use during incidents.

- The District Traffic Engineering Signal Shop manages signal operations. Some timing changes and initial diagnosis is performed through dial-up access to those signals with remote communication capability. Others require site visits for any service. Requests for signal service

are received during normal working hours by the signal shop directly, the district switchboard, or Traffic Engineering. During off hours, an answering service receives calls and pages or phones a technician on call. A rotating list of on-call signal technicians is maintained and used for off-hours emergency contacts.

This pragmatic approach is derived from the devices and communication network in place. As the District ITS network becomes more complex, the proposed concept of operations will help the District benefit from planning and integration of both devices and software. Those benefits include central operation, automated information sharing, operational consistency, and resource sharing on a daily basis and when the transportation system and staff are taxed by incidents and/or weather conditions.

ES-4 OVERVIEW of PROPOSED Phases I and II

The long range vision for ITS in the Staunton District considers a ten-year time frame. The District Operations Center (DOC) is intended to be the "nerve center" of ITS operations throughout the District. To ensure consistency in operations and to best serve District needs, the DOC will be staffed 24 hours a day, 7 days a week.

The role of the DOC is to support maintenance and operations staff activities and ultimately enable more efficient traffic operations throughout the District. The entire District will have monitoring capability and access to the DOC through the intranet. As has already begun, Detection and notification devices will be installed throughout the District. This long-range concept describes the integrated functions that will be enabled through software. This concept also describes two phases of implementation:

- Phase I – Proposed to be in place until the District Operations Center is implemented or approximately year 2002. It includes installation of additional VMS, road and weather information sensors, and cameras in the District.

- Phase II – Begins when the District Operations Center comes online, approximately 2003-2010. The District will achieve the ability to serve customers, monitor and react to traffic on a 24-hour per day 7day per week basis. Additional ITS devices and automated systems will be put in place.

This document will formalize what has been a somewhat informal approach to VMS, HAR and other ITS operations. It has become necessary to ensure uniformity of operations and to establish a process that will be in place as the District Operations Center is completed and staffed.

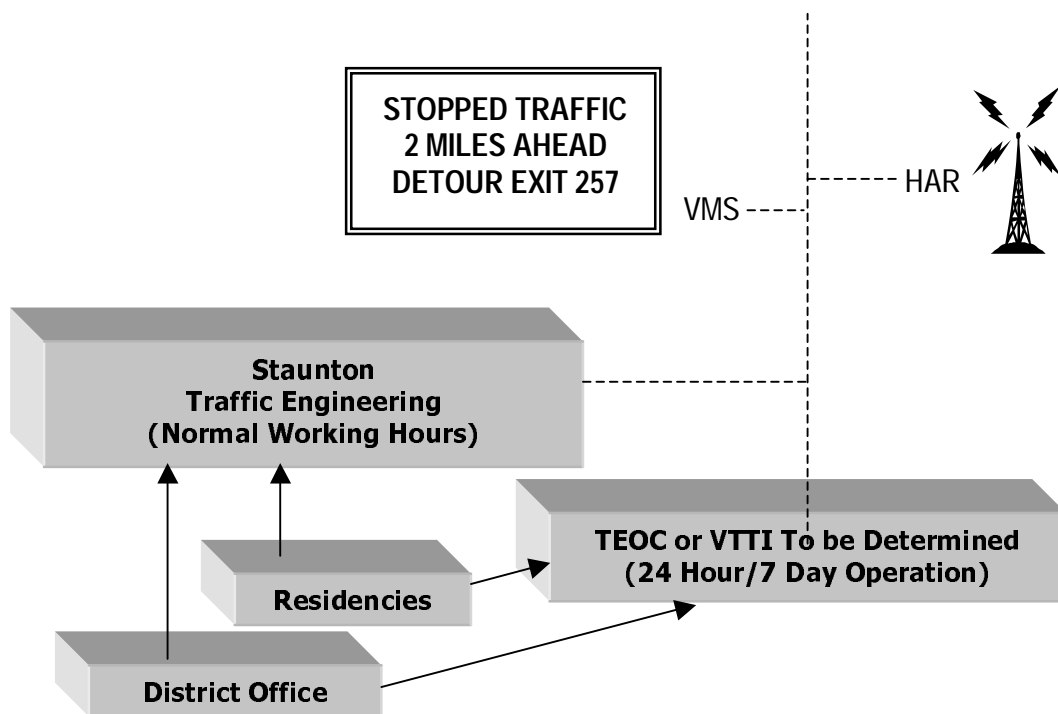The Phase I Concept of Operations is depicted graphically in figure ES-2 below.

STOPPED TRAFFIC
2 MILES AHEAD
DETOUR EXIT 257

VMS

HAR

Staunton
Traffic Engineering
(Normal Working Hours)

Residencies

District Office

TEOC or VTTI To be Determined
(24 Hour/7 Day Operation)

Figure ES-2
Phase I Concept of Operations

Traffic Engineering staff are available during normal working hours to provide support to the Residencies and District Office by posting VMS and HAR messages. Traffic Engineering staff will use dial up telephone lines for connection to VMS's and HAR's. During off hours, the Residency or District Office may soon request support from TEOC or VTTI for VMS and HAR message posting. VTTI is currently drafting a proposal to the ITS Division and Districts incorporating the Interstate 81 corridor to operate such devices until each District brings a District Operations Center (DOC) online. Such a proposal could offer in uninterrupted access to devices and continuity throughout the Interstate 81 corridor.

Figure ES-3 below provides a graphical representation of the proposed Phase II Concept of Operations.

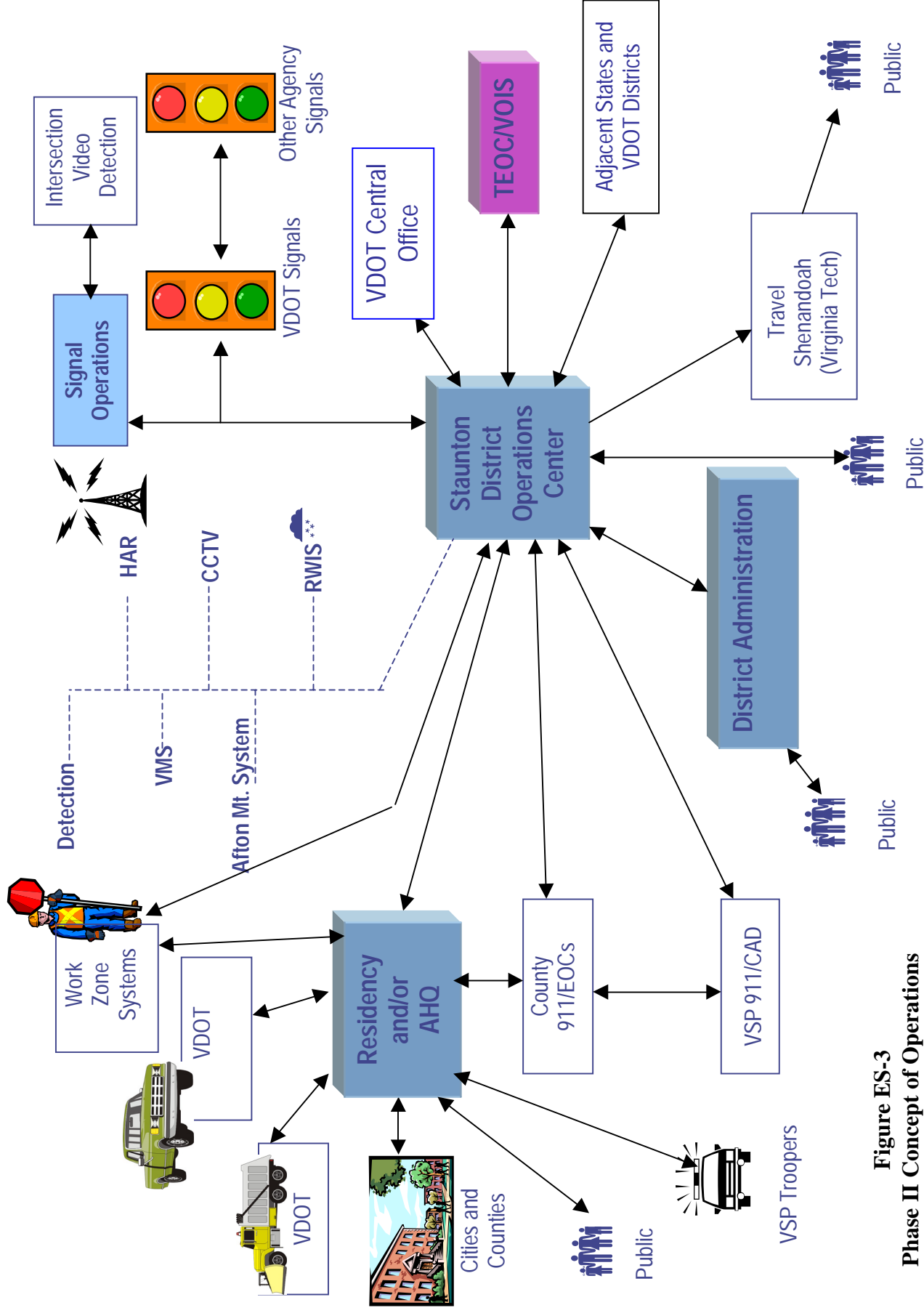# VDOT Staunton District ITS Concept of Operations

Figure ES-3
Phase II Concept of Operations

The section below includes a functional description of the Phase II concept. This description will support development of the integrated system software needed to support DOC operations.

The DOC is intended to be the location where software to operate the field devices is located. It is also intended to be a site where data and information is collected and disseminated to local and statewide users. Access to the information flowing through the DOC will be made available by installing DOC viewer workstations at Residencies, the District Office, and other offices as needed.

The intent of this plan is not to remove local decision-making from ITS operations. The operations performed within the Staunton District flow up from the personnel who are in contact with the events such as incidents, snow removal operations, and maintenance. To reflect this flow, the concept of operations starts at the ground level and follows the information through the organization to the DOC.

The system will allow residences or Area Headquarters to access device data. In addition, the system can enable local control of devices, if necessary. All data, i.e. sign messages, sensor readings, video, etc will be made accessible to designated VDOT staff via the viewer workstations. Access to the control of the devices will be defined in the system software. This approach will allow staff to perform ITS functions from any location with a DOC viewer workstation, and will allow changes in control according to time of day or other factors.

ES-4.1 District Operations Center (DOC)

As the center of ITS operational control for the region, the DOC will be actively connected to District Administration, all residencies, all Area Headquarters if necessary, and each VSP division. Properly implemented and operated, the DOC will become an indispensable service to VDOT staff and travelers.

The DOC will operate with a combination of automated software-supported methods and more conventional means such as phone and e-mail. Remote workstations and intranet will be the primary access method to provide DOC connectivity to remote users. The long-range vision includes the following DOC functions:

- Operate and monitor video cameras, roadway and weather information systems, traffic speed and volume detectors, and VOIS and VSP systems.

- Post messages on VMS and HAR, coordinate messages across the District, and regionally.

- Monitor works zone ITS systems.

- Monitor and have the capability to operate the Afton Mountain Fog system

- Import VSP Computer-Aided Dispatch (CAD) system traffic incident data into the central DOC software for up-to-the minute incident status information.

- Notify District Administration, Residencies, VSP, and other appropriate parties of incident occurrence and status when initially discovered by DOC staff.

- Input data to VOIS via an automated interface of the proposed central software.

- Export data to Travel Shenandoah. Import data from Travel Shenandoah.

- Merge automated vehicle location (AVL) data provided from residency-based AVL systems, to create a district-wide view of vehicle location.

- Provide traffic data to VDOT Central Office Archived Data system, as requested by Central Office.

- Telephone and e-mail communications with local cities and counties for the purpose of managing traffic due to construction, incidents, and weather.

- Respond to non-business hour telephone requests from local EOCs/911 as needed and directed by Residencies. Input information into the DOC system.

- Respond to non-business hour telephone calls from the public. Forward calls or messages to the appropriate organizational unit.

- Act as District Traffic Technology and Analysis center, providing data analysis and reports, e.g. crash record utilizing geographic information software (GIS), traffic counts, etc to the public, District Administration, Residencies, and Central Office.

- Coordinate operations with other VDOT District DOC's, i.e. NOVA DOC, Salem DOC, Bristol DOC, Culpeper DOC, etc with requests to post messages on VMS and HAR to manage regional congestion and incidents

- Coordinate operations with Pennsylvania, Maryland and West Virginia traffic management staff. Respond to requests to post messages on VMS and HAR to manage congestion and incidents.

It is estimated that the functions above will warrant continuous operation, i.e. 24 hours per day 7 days per week. The preliminary floor plan of the DOC will accommodate 5 ITS MEL, including two operators in the control room. The DOC will include additional space for Traffic Engineering. As more space is required later in Phase II, the District will need to consider vertical expansion of the DOC. Consideration for such expansion will be included in the DOC structural design.

Staffing considerations are explained in section ES-7.

Figure ES-4 below is a preliminary drawing of the District Operations Center.
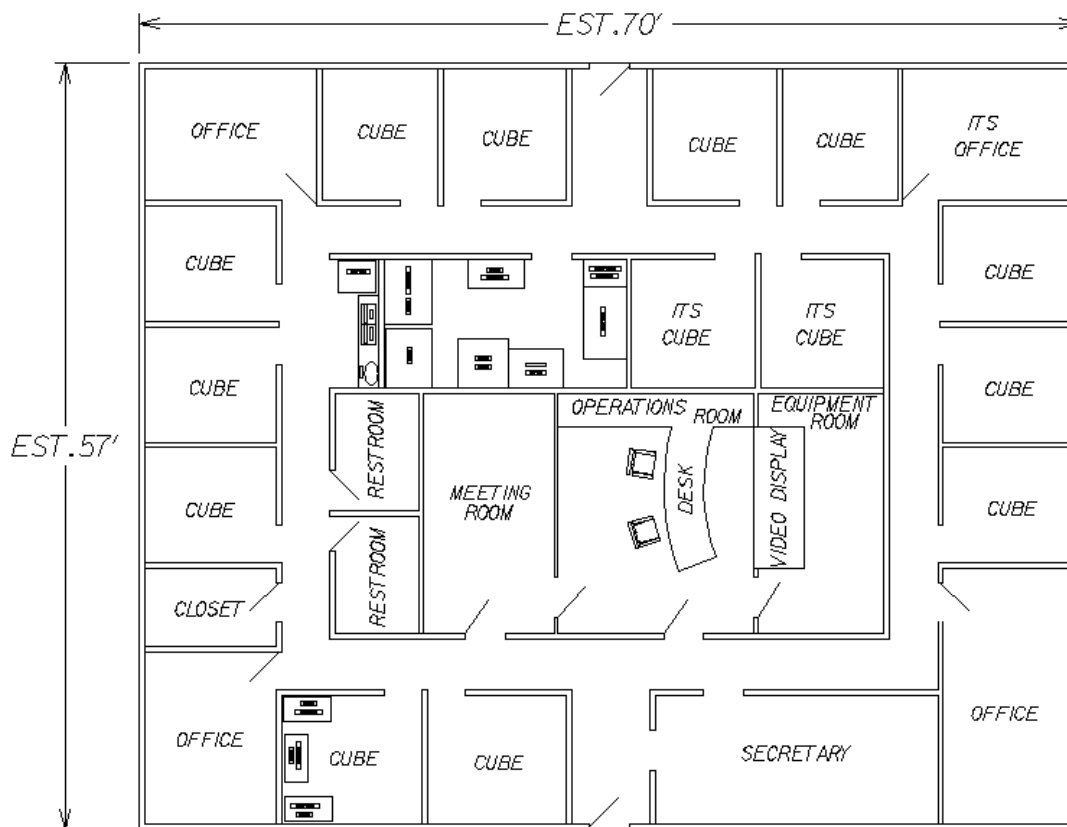
Figure ES-4
District Operations Center

ES-5 phase I short term plan

Phase I includes calendar years 2001 through 2002. This time period will be critical in determining the success of ITS in the District because the foundation will be put in place upon which all subsequent activities will rely. The single opportunity to design a building and software to support ITS for an indefinite period will present itself immediately. Included below are considerations to guide the District through Phase I. Field device and location recommendations follow. The plan is flexible and can be modified to meet budgetary criteria and specific needs yet undiscovered.

The highest priority operational needs in the District are:

- Provide a central location, physically and electronically, to report and access information for the entire District 24 hours a day, 7 days a week. Properly designed, a "nerve center" will assist VDOT staff and improve customer service through enhanced communication and efficient use of assets.

- Improve the accuracy, quantity, and timeliness of traffic data on Interstate 81. Determine the highest crash occurrence locations in the District. Improve incident information to support the District in locating and estimating incident delays.

- Provide information to travelers on the Interstate 81 corridor regarding incidents. The information should occur en-route, e.g. VMS, and pre-trip, i.e. Travel Shenandoah.

- Improve weather and road condition information available to the Residencies to ensure the capability for timely and appropriate response.

The "tools" necessary to address the above needs are:

- A District Operations Center to include a control room, central software, and personnel to manage collected, incoming, and outgoing information. Collected Information includes that from ITS elements such as video cameras and traditional sources such as telephones. Disseminated information will be sent to ITS devices such as VMS mple and traditional channels such as Residencies.

- Non-Intrusive Detection on I-81 in the Harrisonburg area. At five interchanges, in advance and following the interchange, one in each direction, for a total of 20 devices at ten locations. Detection could provide speed and volume information on a continuous basis. This type of detection would be a pilot test for the District and VDOT. Currently there is no detection of this type on VDOT rural interstate. An alternative is to spread the detection throughout the district, though this may raise costs or dilute the sampling rate beyond an acceptable level. Specific detection locations will consider further prior to installation.

- Variable Message Signs (VMS) at key decision points on I-81. Seven locations have been identified, in addition to those installed in the Verona Residency.

- Closed Circuit Television cameras (CCTV) at high incident locations on Interstate 81, and in the Luray Residency. Five locations have been identified.

- Road/Weather Information Sensors (RWIS) with video will provide remote capability to gauge weather conditions at critical locations that currently can not be monitored continuously. The same locations may serve to detect advancing weather fronts. Five locations have been identified throughout the District.

- Communications to field devices, either wireless or wire line will be essential to any system.

The approximate number and location of these devices are shown in Figure ES-4 below. Appendix A of the report includes detailed figures of the existing and proposed Phase I field devices by Residency.
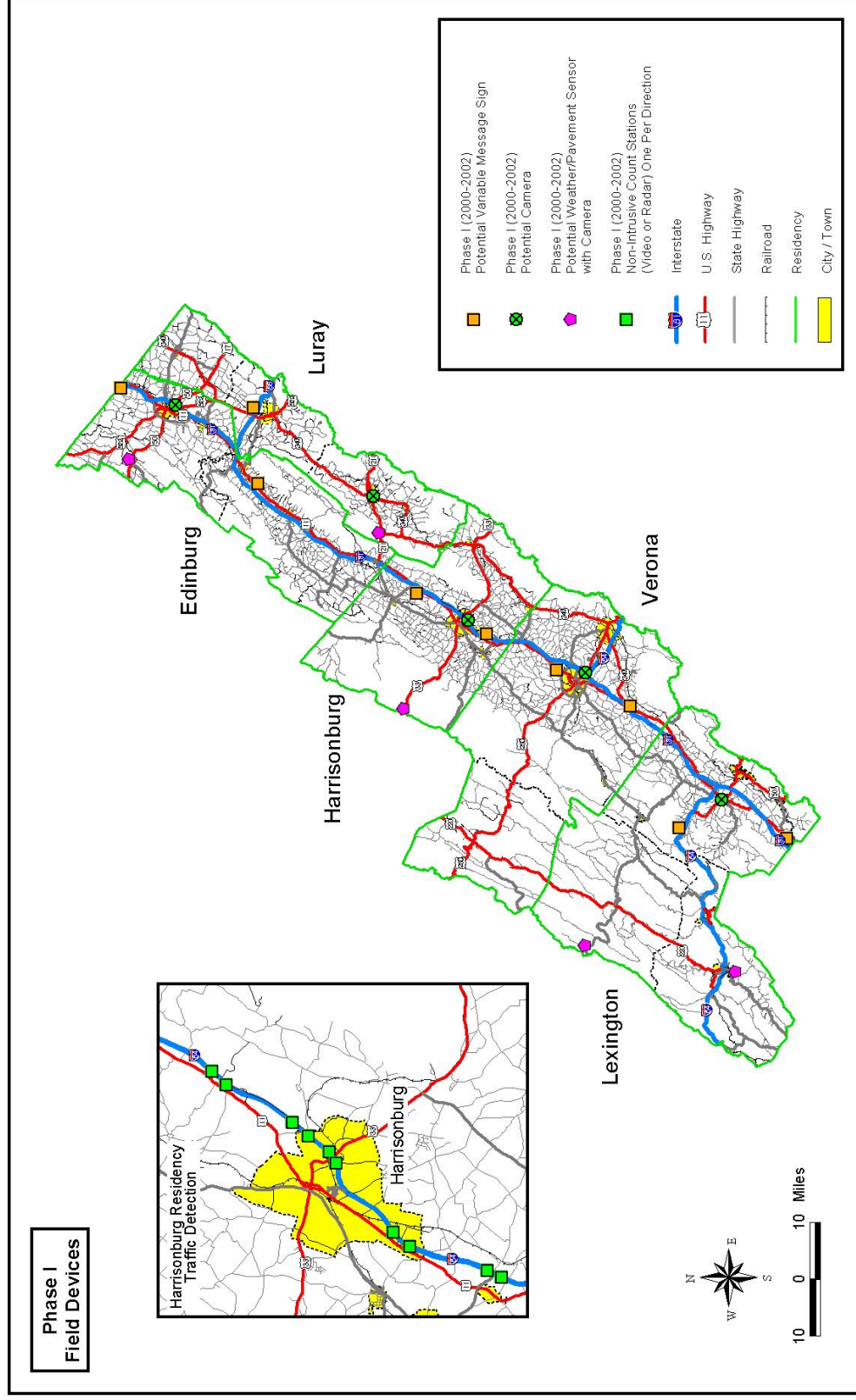
Phase I
Field Devices

Harrisonburg Residency
Traffic Detection

Harrisonburg

Luray

Edinburg

Harrisonburg

Verona

Lexington

Phase I (2000-2002)
Potential Variable Message Sign

Phase I (2000-2002)
Potential Camera

Phase I (2000-2002)
Potential Weather/Pavement Sensor
with Camera

Phase I (2000-2002)
Non-Intrusive Count Stations
(Video or Radar) One Per Direction

Interstate

U.S. Highway

State Highway

Railroad

Residency

City / Town

N
W   E
S

10   0   10   Miles

**Figure ES-4
Phase I Potential Field Devices**

Fixed HAR was not included for Phase 1 consideration. It is included in Phase II. HAR is one of the lesser effective methods of communicating general crash and closure information to drivers, it would not accrue the highest operational benefits, as required for selection of Phase I devices. HAR is very effective at spot locations such as mountain passes, work zones and airports, where the driver can assume what the general content of the information might be, and then choose to tune in or not. In addition, it is anticipated that HAR will be replaced by future technologies over the next ten years, including those that rely on in-vehicle devices. Therefore, investments in HAR for general crash notification, even in Phase II, should be made conservatively.

ES-5.1 Phase I Cost Estimate

The following Table ES-1 summarizes the estimated equipment costs for potential devices identified for Phase I.

Table ES-1
Phase I Estimated Costs

ITEM	UNIT COST	QUANTITY	TOTAL
Non-Intrusive Detection	$20,000	10	$200,000
VMS	$250,000	7	$1,750,000
CCTV	$24,000	5	$120,000
RWIS with video camera	$50,000	5	$250,000
Central Software	$500,000	1	$500,000
DOC	$875,000	1	$875,000
	Subtotal		$3,695,000
	10% Contract Administration		$369,500
	15% Design and Oversight		$554,250
	GRAND TOTAL		$4,618,750

ES-6 Phase II long term Plan

With a foundation in place and lessons learned from Phase I, Phase II focuses on additional equipment. Ultimately the process in Figure ES-1 on Page ES-2 will determine the projects and equipment to result from phase II. Potential ITS devices and locations are included in the long-term plan below. Appendix A of the report includes detailed figures showing the location of proposed Phase II field devices.

- Non-Intrusive Detection on the Interstates between 54 interchanges. One detector in each direction; 108 additional devices.

- Variable Message Signs (VMS) at key decision points on interstates and primaries; 25 additional locations.

- Highway Advisory Radio (HAR) at key decision points on interstates and primaries; 13 additional sites.

- Closed Circuit Television cameras (CCTV) at high incident and congested locations; 18 additional locations.

- Road/Weather Sensors (RWIS) with video cameras, at locations where weather conditions are of concern and at locations to detect advancing weather fronts; 20 additional locations.

- Improved Communications to field devices via wireless, wire line or fiber optic resource sharing.

- Central System Software upgrades required by changes in supporting technology, additional field devices, and increased functionality to support operations.

Table ES-2
Phase II Estimated Devices

DEVICE	EXISTING	PHASE 1	PHASE 2	TOTAL
Variable Message Sign	10	7	25	42
Highway Advisory Radio	7	0	13	20
RWIS	3	5	20	28
Camera	0	5	18	23
Traffic Signal Video Detection*	50+	0	0	0
Non-Intrusive Detection	0	10	108	118

*Traffic Signal Video Detection will expand under new construction projects and loop replacement projects

ES-6.1 Phase 2 Cost Estimate

The following cost estimate for Phase 2, shown in Table ES-3, should be used for preliminary guidance only. New technologies and opportunities will arise in the future that will change overall costs and capabilities of ITS. In addition, changes in priorities and needs will change the number and location of devices installed in the future.

Table ES-3
Phase II Estimated Capital Costs

ITEM	UNIT COST	QUANTITY	TOTAL
Non-Intrusive Detection	$10,000	108	$1,080,000
VMS	$250,000	25	$6,250,000
CCTV	$24,000	18	$432,000
RWIS with video camera	$30,000	20	$600,000
HAR	$60,000	13	$780,000
Intersection Video Detection	Signal Budget	0	$0
Communications (8 year budget)	$1,280,000	1	$1,280,000
Central Software Upgrades	$1,200,000	1	$1,200,000
DOC Equipment Upgrades	$200,000	1	$200,000
		Subtotal	$11,822,000
		10% Contract Administration	$1,182,200
		15% Design and Oversight	$1,773,300
		GRAND TOTAL	**$14,777,500**

THE TOTAL PHASE II CAPITAL COSTS ARE ESTIMATED AT $14.8 MILLION, FOR THE PERIOD FROM 2002 THROUGH 2010. FOR BUDGETARY PLANNING PURPOSES, AN ANNUAL BUDGET OF $1.86 MILLION SHOULD BE CONSIDERED. OF COURSE, THIS IS ONLY A LONG-RANGE ESTIMATE. SPECIFIC NEEDS AND COSTS MUST BE IDENTIFIED AS EACH BUDGET WINDOW APPROACHES.

ES-7 staffing recommendations

This section summarizes the suggested staffing levels and methods for implementing staff. Sufficient lead-time must be allocated to establish new positions, develop position descriptions, salary classifications, recruiting, hiring, and training staff so that personnel are available to support field devices, hardware, software, and communication systems.

Initially, the ITS Program supervisor should be employed before implementation of any ITS project. Operations and maintenance personnel should be employed prior to system construction to receive training provided by the contractor or system manager, review documentation, and participate in system testing. The District has been successful thus far in acquiring an ITS Program Supervisor, Engineer I, as well as a position for a technical assistant, Technician III.

As mentioned previously, the District currently holds 2 MEL positions for ITS. The preliminary floor plan of the DOC will accommodate 5 MEL, including two operators in the control room. As more room is required later in Phase II, the District will need to consider vertical expansion of the DOC. Consideration for such expansion will be included in the DOC structural design.

It is suggested that Staunton District proceed with staffing as follows:

1. DOC Operations – As explained in section ES-4.1, it is anticipated that the DOC will operate 24 hours per day 7 days per week. That schedule constitutes 8,760 hours annually. With a 40-hour workweek and approximately 3.5 weeks of vacation, 11 holidays, and 2 weeks of sick time, a single employee will work 1775 hours per year, in agreement with the Workload Assessment System. Therefore The DOC will require 6 full time operator positions, including one operator supervisor. Such a staff will allow 1890 additional hours for shift changes and unforeseen events that require 2

operators. Some experts argue that two operators are required at all times to remain attentive and provide relief for one another. The District believes such staffing to be redundant and inefficient.

The operations staff requirements can be met either entirely through VDOT hire, as is done at the Richmond DOC, entirely via private sector, as is done in Cincinnati, OH, or via a mix of private and public staff. In Hampton Roads, the DOC operations manager is a VDOT employee, while the operators are contract staff. This last method may be best for the first few years of operations, as the private sector may supply qualified and flexible staff more quickly. The Staunton District could then choose to retain or phase out contract staff in favor of VDOT staff.

It is important to note the Augusta Headquarters of the VSP has indicated interest in co-locating at the proposed Staunton District DOC. Space limitations and location of the proposed DOC will make collocation of the entire Headquarters unattainable. However, the DOC will be designed to accommodate two operator positions. It is recommended that the opportunity to share an operator's station on an as needed basis with the VSP be pursued. Such a relationship would almost certainly benefit VDOT, VSP, and travelers through improved communication and coordinated service. Also, operator attentiveness during periods of single staffing could benefit from periodic VSP visits, thus reducing the demand for 2 operators per shift.

DOC Operations Staffing Level
Phase I: 1/3 Technician FTE position INCLUDING VTTI or TEOC assistance
Phase II: 6 operator FTE positions INCLUDING 1 supervisor for 24/7 operations.

2. DOC Maintenance - VDOT IT staff are qualified to maintain or contract maintenance of existing personal computers similar to those to be installed in the Staunton DOC. However, specialized software and some hardware in the DOC will call for additional support. It is suggested that VDOT contract service with equipment. A service contract can be included under software or hardware supplier contracts. Even with contracted maintenance, the DOC will require a "resident expert" in the field of hardware and software maintenance to oversee contractors and system integration. Any contract should ensure that the developer use best practices in software development and documentation, so that a vendor or VDOT can maintain and expand systems in the future.

DOC Maintenance Staffing Level:
Phase I: 1/3 Technician FTE position
Phase II: 1 Technician FTE position, potential for 2 FTE in the later stage of Phase II

3. Field Device Maintenance – Similar to DOC equipment, field device contracts may be written to include extended service by the contractor and/or device supplier. This type of warranty should be a separate pay item in the contract to avoid prepayment.

At the conclusion of the warranty period, there are at least three options. First, contract field maintenance to a private contractor. It is recommended that the District issue an RFI for field maintenance one year in advance of the expiration of warranties. The response to the RFI can help determine if contracting out for the District is advisable, or if the District should pursue one of the other two options available to them. The RFI should include requirements for local staffing, response time to trouble calls, preventative maintenance cycles, and required procedures for working in State right-of-way.

The second option is to join with other Districts to contract out for maintenance. A larger number of devices to maintain means the contract dollar value will be greater, and this may attract more bidders. It is possible that this contract could be managed from another DOC on the Interstate 81 corridor.

Last, VDOT can choose to procure equipment and hire staff to maintain the field equipment as a VDOT function. It may be easier to hire the staff in a more rural area where competition for highly skilled workers is less intense, and where the cost of living and VDOT benefits increase the job attractiveness. A program to maintain and increase staff skills as technologies are introduced must be developed to ensure staff continues to be qualified into the future.

Field Maintenance Staffing Level:
Phase I: 1/3 Technician FTE position
**Phase II:**   2 Technician FTE positions AND 1 Technician Supervisor FTE position

ES-8 Development of VMS and HAR Message Protocols

Comments regarding the need to standardize messages on VMS and HAR were received from several District staff during the interview phase of this project. Standardized messages and a protocol that establishes which messages are to take precedence over others will become essential to advise travelers and manage local, regional, and District-wide incidents.

Two reports produced by the FHWA specify guidance on posting sign and radio messages. They are:

- Guidelines on the Selection and Design of Messages for Changeable Message Signs FHWA Report /TX-92/1232-10

- Highway Advisory Radio, Message Development Guide FHWA/ Report RD- No. 82/ 059 Final Report October 1982

These reports should be used in developing a message format template as shown in Figure ES-5 below:

<WHAT HAS HAPPENED>

<WHERE>

<WHAT SHOULD THE DRIVER DO>
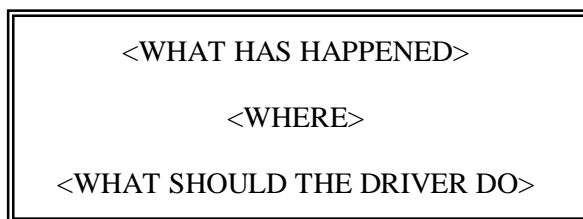
Figure ES-5
Message Format template

The above format will provide a consistent message type on VMS and HAR to all drivers. A series of standard messages or message templates should be developed immediately. Messages and guidelines should be shared with adjacent Districts. Message priorities should be adopted uniformly across District boundaries to provide consistency throughout a corridor.

Message priorities should be assigned to different message types. Message priority will determine which message go up when two or more different requests occur simultaneously. Allocation of priorities and agreement among Districts will reduce the potential for conflicting messages and conflicting opinions on the most appropriate message. The national approach to priority assignment is based on the following hierarchy:

1. Closure

2. Accident

3. Lane Closure

4. Shoulder Activity, Hazardous Road Conditions and Snow Plow Operations

5. Sign Testing

Additional detail on messages and classes in this hierarchy particular to Staunton District operations should be developed and maintained. For instance, future surveillance/detection capabilities on Interstate 81may allow travel time message sets in the future.

ES-9 summary

This Executive Summary has overviewed the Staunton District ITS Concept of Operations. Further detail, explanation, and figures are in included in the main document.